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EXPERIMENTAL RESEARCH ON THE VISCOSITY OF META-XYLENE AT HIGH PRESSURES AND TEMPERATURES

by

A. M. Mamedov, T. S. Akhundov, and A. D. Tairov

EDITED TRANSLATION

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

* ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

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13. ABSTRACT

The viscosity of m-xylene was detd. at given intervals by the capillary method. The exptl. unit consisted of a capillary viscometer made of refractory glass and housed in a high-pressure chamber. The latter was connected directly to one end of a U-tube, the other end being joined to the pressure system. The chamber was fitted with a Cu jacket to equalize the temps. inside it. Temps. were measured with plus or minus 0.02-0.05 degrees with a Pt resistance thermometer, and 3 chromel-alumel thermocouples regulated the temps. along the length of the jacket. The diam. of the capillary was detd. using given material and water. The given values (186 detns.) were graphically depicted. Comparison of these with the available given values at atm. pressure and different temps. showed a max. divergence of 1.5 percent.

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EXPERIMENTAL RESEARCH ON THE VISCOSITY OF META-XYLENE AT HIGH PRESSURES AND TEMPERATURES

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Analysis conducted on the fundamental methods of measuring the viscosity of hydrocarbon fluids shows that for the stated purpose, i.e., the study of the influence of pressure and temperature on viscosity, the capillary method is the most suitable. This method is the most highly developed and most soundly based theoretically [1, 2].

To investigate the viscosity of hydrocarbons, we erected an experimental device according to a procedure developed by I. F. Golubev and N. A. Agayev [1, 2]. The setup of the experimental device is given in Fig. 1.

Viscometer 1, made of "supromaks" brand refractory glass, is placed into high-pressure jar 2, which by means of a tube is connected with U-shaped elbow 4 that separates the fluid and the oil. The other end of the U-shaped elbow connects with sample 7 and MP-600 5 and MP-60 6 dead-weight piston gages of class 0.05, used to create and measure pressure in the device.

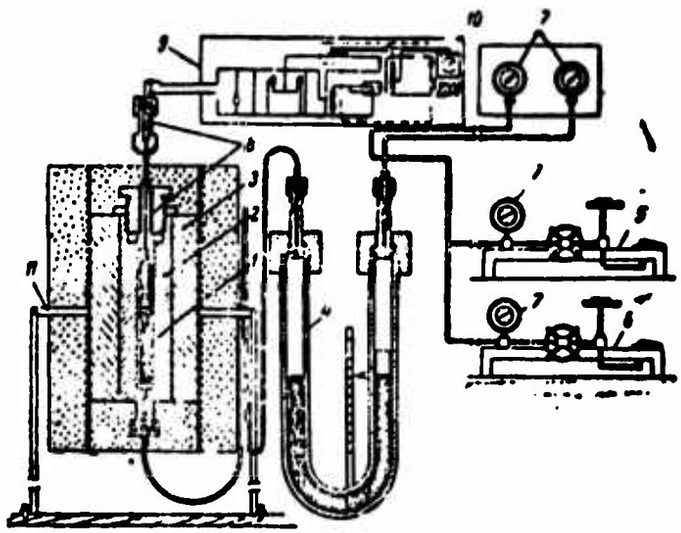

Fig. 1.

To equalize the temperature field along the length of jar 2, copper jacket 3 is placed over it and hot-fitted. The temperature was measured by a sample platinum resistance thermometer with ±0.02-0.03°C accuracy. To equalize the temperature along the whole length of jar 2, three chromel-alumel thermocouples were placed in copper jacket 3.

Electrical heaters, regulated according to the readings of a differential thermocouple were mounted on half-axles 11 to avoid dissipation of heat over them.

The time of outflow of the mercury between the contacts of the viscometer was measured by automatic electrical timer 10 with amplifier 9. The contacts of the viscometer were led out through special device 8 with a conical seal. The operating principle and description of the viscometer are given in detail in works [1, 2, 3].

The geometric dimensions of the viscometer used for the given study were determined with the help of a KM-6 cathetometer and an MIR-2 telescope.

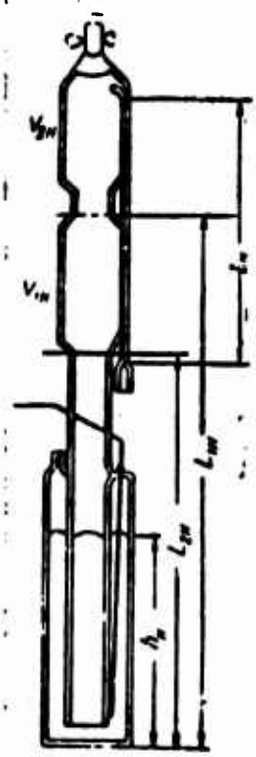

Fig. 2.

The volumes of the measuring and preliminary bottles were repeatedly determined by the mercury, and calculation was carried out in terms of the average value.

A schematic of the viscometer is given in Fig. 2.

The diameter of the viscometer capillary was determined by the relative method, by conducting experiments on well-studied materials. The materials *n*-heptane and common water were selected as agents for determining the diameter of the capillary [4, 5, 6]. The results of two measurements showed good agreement; the divergence does not exceed 0.01%. On the given device the viscosity was measured with weight concentrations of 99.4% meta-xylene on 11 isotherms: 22.2, 50.13, 74.78, 99.97, 125.01, 149.99, 175.00, 200.02, 225.00, 250.01, 275.00, and with pressures of up to 400 bars.

The 0.60% impurity contained 0.31% ortho-xylene, 0.26% para-xylene, and 0.03% ethyl benzene, which was determined on a chromatograph with a flame-ionization detector.

In all, 186 experimental values on the viscosity of *m*-xylene were obtained. To check the reproducibility of the experimental findings, the outflow time in the experiment in each equilibrium state was measured several times. A more accurate equation for calculating the coefficient of dynamic viscosity of a fluid includes a number of corrections caused by the procedural and structural peculiarities of the device [2] and has the form

$$\eta = A\left(C_t - a\frac{\rho_{p.n.}}{\rho_{pr}}\right)(\rho_{pr} - \rho)\tau - B_t\frac{\rho}{\tau}, \qquad (1)$$

where

$$A = \frac{\pi \cdot g \cdot r_н^4 \cdot H_н}{8 \cdot V_{1н} \cdot l_н}; \quad (2)$$

$$B_1 = \frac{m \cdot V_{1н}(1 + 2 \cdot a \cdot \Delta t)}{8 \cdot \pi \cdot l_н}; \quad (3)$$

$$C_1 = \left(1 + \frac{h_н + 3a \cdot L_н \cdot \Delta t}{H_н}\right). \quad (4)$$

In formulas (2), (3), (4)

$$H_н = \frac{H_{1н} - H_{2н}}{2{,}3 \lg \frac{H_{1н}}{H_{2н}}} \quad (5)$$

$$L_н = \frac{L_{1н} + L_{2н}}{2}, \quad (6)$$

where $r_н$ - the radius of the capillary, equal to 0.0074325 cm; $l_н$ - the length of the capillary, equal to 5.280 cm; $V_{1н}$ - the volume of the measuring gas bottle, equal to 1.02550 cm^3; $V_{2н}$ - the volume of the preliminary gas bottle, equal to 0.79876 cm^3; $H_{1н}$ - the difference in the mercury levels in the viscometer at the beginning of outflow, equal to 6.9939 cm; $H_{2н}$ - the difference in the mercury levels in the viscometer at the end of outflow, equal to 3.7515 cm; $h_н$ - the height of the mercury level in the lower gas bottle, equal to 4.6705 cm; $L_{1н}$ - the height of the mercury column in the viscometer at the beginning of outflow, equal to 10.2794 cm; $L_{2н}$ - the height of the mercury column in the viscometer at the end of outflow, equal to 7.9881 cm.

Table 1.

P, bar	t, °C						
	20	50	100	150	200	250	275
1	0,8619	0,8406	0,7967	0,7474	—	—	—
50	0,8684	0,8447	0,8026	0,7551	0,7025	0,6438	0,6135
100	0,8718	0,8487	0,8074	0,7623	0,7132	0,6612	0,6169
150	0,8752	0,8526	0,8125	0,7692	0,7229	0,6759	0,6557
200	0,8785	0,8563	0,8171	0,7755	0,7316	0,6886	0,6708
250	0,8816	0,8599	0,8218	0,7815	0,7398	0,6999	0,6844
300	0,8847	0,8634	0,8262	0,7871	0,7483	0,7101	0,6964
350	0,8877	0,8668	0,8304	0,7928	0,7543	0,7195	0,7073
400	0,8906	0,8701	0,8345	0,7977	0,7609	0,7281	0,7173

Table 2. The viscosity of *m*-heptane (10^{-6} $g \cdot cm^{-1} \cdot s^{-1}$).

P, bar	t, °C										
	22,21	50,13	74,78	99,97	125,01	149,99	175,00	200,02	225,00	250,01	275,00
1	5939	4317	3434	2832	—	—	—	—	—	—	—
8,19	—	—	—	—	2433	—	1733	1475	—	—	—
9,83	—	—	—	—	—	2036	—	—	1245	—	—
13,10	—	—	—	—	—	—	—	—	—	1059	—
25,50	6098	4422	3517	2903	2477	2073	1763	1512	1284	1084	915
50,01	6185	4515	3599	2978	2532	2126	1816	1561	1334	1139	972
74,53	6310	4608	3676	3048	2591	2179	1868	1610	1384	1194	1030
99,05	6410	4713	3748	3116	2647	2233	1921	1658	1432	1249	1086
123,56	6555	4796	3817	3189	2706	2288	1973	1707	1480	1299	1133
148,08	6651	4868	3888	3258	2766	2343	2025	1752	1529	1346	1180
172,60	6778	4979	3969	3328	2820	2397	2075	1800	1476	1387	1223
197,11	6837	5061	4041	3399	2876	2450	2122	1845	1621	1428	1267
221,63	7024	5139	4113	3458	2931	2503	2169	1889	1665	1469	1308
246,15	7146	5259	4196	3524	2983	2554	2217	1934	1709	1510	1346
270,66	7276	5344	4277	3590	3035	2604	2264	1975	1750	1551	1385
295,18	7401	5443	4346	3643	3087	2654	2311	2008	1792	1591	1422
319,70	7551	5541	4415	3710	3139	2705	2358	2060	1833	1630	1457
344,21	7668	5650	4490	3776	3194	2755	2406	2102	1874	1670	1494
368,70	7818	5745	4571	3840	3240	2805	2453	2145	1916	1710	1531
393,28	7952	5838	4647	3906	3295	2856	2499	2188	1958	1750	1567

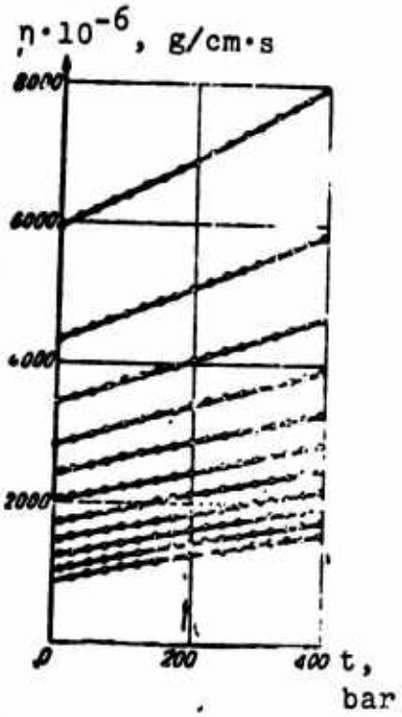

Fig. 3.

The values of density ρ of meta-xylene at various temperatures and pressures that were obtained in the laboratory of the Azerbaydzhan Institute of Petroleum and Chemistry by A. M. Mamedov, T. S. Akhundov and N. N. Asadullayeva are given in Table 1. On the basis of the general theory of errors, we estimated the error of the obtained experimental findings for viscosity for the fluid state to be 1.2%.

The experimental findings on the viscosity of the studied *m*-xylene are presented in Table 2 and in Fig. 3 in the η–P diagram.

As is apparent from Table 2 and Fig. 3, a sufficient amount of experimental values for viscosity were determined on each isotherm.

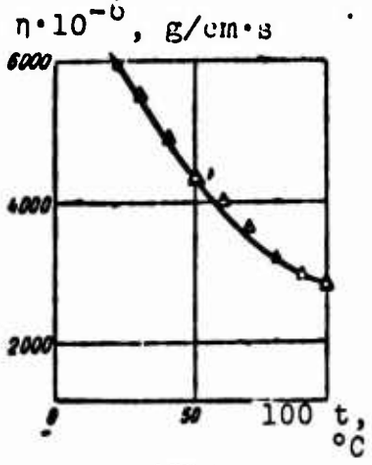

Fig. 4. O - findings of the authors; Δ - findings of [7].

The values which we obtained on the viscosity of meta-xylene were compared with the only data available in the literature: at atmospheric pressure and various temperatures [7, 8]. As is evident also in Fig. 4, the findings [7, 8] have a certain spread. The maximum deviation is 1.5%.

One should note that the *m*-xylene viscosities which we measured are unique.

Bibliography

1. Голубев И. Ф. Вязкость газов и газовых смесей. Физматгиз, 1959.
2. Голубев И. Ф., Агаев Н. А. Вязкость предельных углеводородов. Азернешр, 1964.
3. Агаев Н. А., Голубев И. Ф. «Газовая промышленность» № 5, 1963.
4. Халилов Х. М. ЖТФ, вып. 8, 13, 14, 1249, 1939.
5. Халилов Х. М. Изв. АН Азерб. ССР, № 63, 1952.
6. Geist M., Conoh M. R. Ind. End. Chem Ind Ed, vol., 38, № 2; 12, 611, 1946.
7. Henning F. Warmetechnish« Richtverte, B., 1938.
8. Варгафтик Н. Б. Справочник по теплофизическим свойствам газов и жидкостей. Физматгиз, 1963